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Thallium labelled citrate coated Prussian blue nanoparticles as potential imaging agent

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Powerful new high-resolution imaging tools such as optical whole body imaging (FOBI), magnetic resonance imaging (MRI) could thus nowadays enable very good anatomical detail fusion to functional image data (positron emission tomography (PET) and single photon emission computed tomography (SPECT)). With the availability of these novel multimodal imaging devices the demand for innovative multimodal contrast materials is higher than ever before.

Our aim was to create a biocompatible Prussian blue nanoparticle (iron(2+);iron(3+);octadecacyanide; PBNP) platform for preclinical imaging which has four important qualities (long-term stability of the NP platform, T1 signal enhancement on MR image, stability of the bond between methylene-blue (MB) fluorescent dye and nanoparticle structure and stability of the bond between the radiolabel and nanoparticle structure. The physical properties of PBNPs were characterized with atomic force microscopy, dynamic light scattering and zeta-potencial measurement. PBNP biodistribution was determined by using FOBI, SPECT and MRI following intravenous administration into C57BL6 mice.

PBNPs appeared as objects with a flat rectangular surface protruding from a rounded halo. Rectangularity of the particles was found to be 0.81±0.09. Height of the particles showed monomodal distribution (23.0±8.3 nm). The non-hydrated size of the NPs were analyzed with TEM (17.54 ± 4.56 nm, n=700). The mean Zeta potential of PBNPs at pH 7.4 was -25.7 ± 1.8 mV (n=3). The mean hydrodynamic diameter of PBNPs was 32.10 ± 0.1801, as determined by DLS. There was no significant colloidal alteration during the 6-week duration of the study (polydispersity index (PDI) 0.203 ± 0.004). T1-weighted and T2-weighted spin echo images of a PBNP containing phantom showed signal enhancement on T1-weighted image instead of decreased signal on T2-weighted image.

MB-labeled PBNP accumulation peaked at 2 hours post injection in the kidneys and the bladder.

After 201Tl labeling the radiochemical purity was >98 % in all experiments. The radioactive labeling yield was 99.84 % (SD: 1.01 %).

PBNP accumulation peaked at 2 hours post injection predominantly in the kidneys and the liver followed by a gradual decrease in activity in later time points.

In this study we successfully synthesized, characterized and demonstrated the biodistribution of citrate-coated MB-PBNP labeled using 201Tl isotope. The results show a chemically stable and biocompatible 201Tl and MB labeled nanoparticulate SPECT tracer and optical contrast material. These PBNP based particles could be applied as a drug delivery platform or a contrast agents in pre-clinical research. They could further be tailored towards clinical application, too.

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